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NOTE ON THE GLACIER OF MOUNT LYELL, CALIFORNIA¹

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The writer had the privilege of visiting the glacier on Mount Lyell on August 17 and 18 of the present year (1904), and of securing the photographs accompanying this note. Mount Lyell is one of the well-known peaks of the High Sierra, although it is by no means the highest, the elevation being only 13,090 feet. On the northern face of the mountain lies a body of ice something over a mile in east-and-west length, and extending down the slope about half a mile. It consists, in reality, of two glaciers lying side by side, and separated in part by a narrow tongue of rock. The present aspect of the glacier is shown in the accompanying photographs.

Two phenomena seem especially worthy of note. First, there is an absence of any large amount of morainal material except at the immediate terminus of the ice. Lyell Canyon, which was formerly occupied by the extended Lyell Glacier, was examined for a distance of about fourteen miles, and only scattered boulders and small beds of morainal material were noted until the present terminal moraine was reached. Abundant evidence of glacial action, however, is present throughout the valley in the form of polished and grooved surfaces, *roches moutonnées*, and domes. The retreat of the glacier to its present position must have been rapid. It is doubtful if the volume of glacial débris now found in Lyell Canyon is much greater than the volume that would be contained at any one time in a glacier filling this canyon to the extent which Lyell Glacier did in former times.

The second phenomenon to which I call attention is apparent on examination of the photographs. In contradistinction to its former rapid retreat, the front of Lyell Glacier has remained at or near its present position for a considerable length of time. It will be noted

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that the ice crowds closely upon the terminal moraines. There is no space between the face of the glacier and the moraine to indicate recent recession. It will also be noted that a very small portion of the old ice is exposed, the greater part of the surface being covered with last winter's snow. At that altitude no great amount of snow will melt after August 18—the date of my visit—before a fresh snow-



FIG. 1.—Lyell Glacier, western lobe. (The snow in the foreground is not a part of the glacier, and the first two masses of rock are not moraines. The moraine is nearly covered with snow.)

fall begins the winter's accumulation. It will be noted, especially in Fig. 1, that fresh snow in large quantities lies outside of the moraines as well as covering the greater part of the glacier. The terminal moraine of the western lobe of the glacier is largely concealed from view by fresh accumulations of snow. The foreground is occupied by a lake nearly covered with ice which has remained all summer, and which is buried on the glacier-ward side beneath many feet of snow. The large mass of snow in the foreground, since it has nothing to do with the main glacier, although it has glacial motion of its own,

can be neglected. Considering, then, only the masses of snow immediately outside of the moraines, the quantity indicates that it must be due to several years' accumulation. In some cases the extra-morainal masses are several hundred feet wide and, judging from the topography, must be forty feet or more in depth.

Turning to an examination of Fig. 2, there is less recent snow than appears in the western lobe, and a larger portion of the old ice is exposed, perhaps because this lobe descends considerably lower than the western lobe. The nose of the glacier is here pushed hard upon the moraine, so that the front of the ice and the moraine form a single slope. The loose morainal material is accumulated in a steep slope, with its base forming a comparatively sharp outline with the rock on which it rests. The relations are such as strongly to suggest that this lobe of the glacier is overriding its terminal moraine and dropping the fresh material at the front.

During the summer of 1883, I. C. Russell photographed this glacier, and his photographs were published in the *Eighth Annual Report* of the U. S. Geological Survey. Twenty years later, during the summer of 1903, G. K. Gilbert secured photographs of the same glacier and published them in the *Bulletin of the Sierra Club*, in an article entitled, "Variations of Sierra Glaciers." In comparing his photographs with those of Professor Russell, Mr. Gilbert says:

The glacier seems now to have almost precisely the same size as at an earlier date, the only suggested change being a slight shrinkage near the west end. The arrangement of the numerous moraine ridges is precisely the same as in 1883, from which it may be inferred that the glacier has not in any later year been materially larger than then. It might, however, have diminished and afterward increased.

Later he observes: "Lyell Glacier was quite as free from snow in the summer of 1883 as in 1903."

From a comparison of Russell's photographs, taken in 1883, Gilbert's, taken in 1903, and the writer's, taken in 1904, it is evident that little change has taken place since 1883. All the main features are the same. Careful comparison, however, indicates that small arms of ice reaching up the rock faces are slightly larger than they were twenty-one years ago, and certain small areas of rock, which

then appeared above the surface, are now covered. A comparison of Mr. Gilbert's photographs of the western lobe with the writer's, taken only one year later, indicates an increase which can be detected from the photographs. For example, in Fig. 1 it will be noted that the snow near the top of the peak above the Bergschrund is continuous to the top. In Gilbert's photograph, taken only one year



FIG. 2.—Lyell Glacier—eastern lobe.

earlier, a continuous line of rock appears across the arm above the Bergschrund. It is very evident, from the clothing of new snow remaining on the glacier through the summer, that the snowfall of last winter has increased the volume of the glacier. It is evident, from the relation of the ice to the moraines, and from the records above quoted, that little or no recession has occurred in recent years. The relation of the morainal front to the underlying rock at the eastern lobe, and the large accumulations of extra-morainal snow in the western lobe, suggest that the glacier may be slowly advancing. It may be confidently stated that for the past twenty-one years there

has been, on the whole, no decrease in volume. It may be further confidently stated that since the formation of the present terminal moraines there has been a somewhat marked increase in the volume of ice, as indicated by the large masses which have accumulated in front of the moraines.